AIRS Version 2.7 L1B Data Release Documentation

Version 1.0.2

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Introduction

The Atmospheric Infrared Sounder (AIRS) instrument suite is designed to measure the Earth's atmospheric water vapor and temperature profiles on a global scale. It is comprised of a space-based hyperspectral infrared instrument (AIRS) and two multichannel microwave instruments, the Advanced Microwave Sounding Unit (AMSU) and the Humidity Sounder for Brazil (HSB). The AIRS instrument suite is one of several instruments onboard the Earth Observing System (EOS) Aqua spacecraft launched May 4, 2002.

Operational L1B Products of the AIRS/AMSU/HSB instrument suite on the EOS Aqua spacecraft are now available for use by the general public. They can be accessed on the web at the URL:

EOS Data Gateway	http://eos.nasa.gov/imswelcome

These data are in the standard HDF-EOS Swath format and can be used for preliminary science evaluations. They include calibrated radiances for all three instruments and Quality Assessment (QA) data. The radiances are well calibrated; however, not all QA data have been validated. A product granule contains 6 minutes of data. Thus there are 240 granules of each product produced every day.

A complete description of the product file contents of the released L1B data products may be found in the companion document titled "**AIRS Version 2.7 Released Files Description**". A PDF file containing Version 1.1 of this document, dated March 2003, is available at the link:

V2.7_Release_ProcFileDesc.pdf

The document provides for each L1B product:

- Dimensions for use in HDF-EOS swath fields (name, value, explanation)
- Geolcation fields (name, explanation)
- Attributes (name, type, extra dimensions, explanation)
- Along-track data fields (name, type, extra dimensions, explanation)
- Full swath data fields (name, type, extra dimensions, explanation)
- Special AIRS types for engineering data fields (name, type, explanation)

It also provides the product file naming and local granule identification (LGID) conventions used in the identifier portion of the EOSDIS Core System (ECS) and a table of all current Science, Engineering and Browse Products (L1A, L1B and L2).

Descriptions of the Level 1B data products provided in that document and instrument and data features provided here are limited to the V2.7 released data set. For additional information, please consult the AIRS public web site:

AIRS Public Web site	http://www.jpl.nasa.gov/airs.

Additional information may be accessed at the following web sites:

AIRS Data Support	http://daac.gsfc.nasa.gov/atmodyn/airs/.
Aqua AIRS Science	http://www.aqua.nasa.gov/AIRS/airs_science.html
AIRS ATBDs	Algorithm_Theoretical_Basis_Docs

Instrument Description and Status

Overview

The AIRS/AMSU/HSB instrument suite has been constructed to obtain atmospheric temperature profiles to an accuracy of 1 K for every 1 km layer in the troposphere and an accuracy of 1 K for every 4 km layer in the stratosphere up to an altitude of 40 km. The temperature profile accuracy in the troposphere will match that achieved by radiosondes launched from ground stations. The advantage of the AIRS suite in orbit is the provision of rapid global coverage. Radiosonde coverage of the Earth's oceans is practically nonexistent. In conjunction with the temperature profiles, the AIRS instrument suite will obtain humidity profiles to an accuracy of 10% in 2 km layers from the surface to the tropopause.

Description of Instruments

The Aqua Instrument Page provides guides to the instruments, including quicktime animations that illustrate their operation:

Aqua AIRS Instrument	http://www.aqua.nasa.gov/AIRS3.html
Aqua AMSU Instrument	http://www.aqua.nasa.gov/AMSU3.html
Aqua HSB Instrument	http://www.aqua.nasa.gov/HSB3.html

AIRS

The AIRS infrared spectrometer acquires 2378 spectral samples at resolutions, $\lambda/\Delta\lambda$, ranging from 1086 to 1570, in three bands: 3.74 μm to 4.61 μm, 6.20 μm to 8.22 μm, and 8.8 μm to 15.4 μm. A 360 degree rotation of the scan mirror generates a cross-track scan line of IR data every 2.667 seconds. The spatial resolution at nadir is 13.5 km. This instrument provides fine vertical scale resolution soundings of atmospheric temperature and water vapor, and integrated column burden for trace gases.

The IR focal plane is cooled to 60 K by a Stirling/pulse tube cryocooler. The scan mirror operates at approximately 265 K due to radiative coupling to the Earth and space and to the 150 K IR spectrometer. Cooling of the IR optics and detectors is necessary to achieve the required instrument sensitivity.

AIRS VIS/NIR

The Visible/Near-IR (VIS/NIR) photometer contains four spectral bands, each with nine pixels along track, with a 0.185 degree instantaneous field-of-view (FOV). It is boresighted to the IR spectrometer to allow simultaneous measurements of the visible and infrared scene. The VIS/NIR photometer uses optical filters to define four spectral bands in the 400 nm to 1000 nm region. The VIS/NIR detectors are not cooled and operate in the 293 K to 300 K ambient temperature range of the instrument housing. The spatial resolution at nadir is 2.3 km. The primary function of the AIRS VIS/NIR channels is to provide diagnostic support to the infrared retrievals: setting flags that warn of the presence of low-clouds or highly variable surface features within the infrared field-of-view.

AMSU-A

The AMSU-A microwave multichannel radiometer consists of two physically separate units, AMSU-A1 and AMSU-A2. Together they have 15 channels, measuring radiation in the frequency span of 23 GHz to 90 GHz. Twelve channels (between 50 GHz and 60 GHz) are predominantly used for atmospheric temperature sounding. The remaining three channels (24 GHz, 31 GHz and 89 GHz) are predominantly used for atmospheric water vapor sounding. The rotating scanning mirror generates a cross-track scan line every 8 seconds. The spatial resolution at nadir is 40.5 km.

HSB

The HSB microwave multichannel radiometer has 4 channels. One channel measures radiation at 150 GHz and the other three are centered on 183.31 GHz. All channels are used for atmospheric water vapor sounding. The rotating scanning mirror generates a cross-track scan line every 2.667 seconds. The spatial resolution at nadir is 13.5 km.

Relation of Fields of View of AIRS/AMSU/HSB

An AMSU-A FOV encompasses 9 AIRS FOVs (arranged in a 3x3 matrix) and 9 HSB FOVs (arranged in a 3x3 matrix). Each AIRS FOV encompasses 72 Vis/NIR pixels (arranged in a 9x8 rectangular array). This arrangement is illustrated in Figure 1, which was produced from the geolocation information contained within Granule 016 of data taken July 20, 2002. The large circle represents the 3.3 deg IFOV of an AMSU-A observation. The smaller colored circles represent the 1.1 deg IFOVs of the associated arrays of AIRS and HSB observations. The colored rectangles represent the areas covered by the associated arrays of VIS/NIR pixels.

Since granule 016 is a descending (nighttime) granule, the spacecraft track tends toward the southwest. The scan direction as seen by an observer sitting on the spacecraft and facing the direction of motion is left to right. Thus the scan direction on the Earth for this granule is right to left in this figure.

A granule of data contains 45 scansets, corresponding to 45 cross-track scans of the AMSU-A mirror. The AMSU-A radiance data sampled in a scanset are combined to create integrated radiances for 30 contiguous AMSU-A footprints.

Within each scanset are three scanlines, corresponding to 3 cross-track scans of the AIRS and HSB mirrors. The AIRS and HSB radiance data sampled in each scanline are combined to create integrated radiances for 90 AIRS and 90 HSB footprints.

The VIS/NIR instrument has an array of 9 detectors arranged along the spacecraft track direction and look at the AIRS mirror. Sampling and integration are arranged so that there are 8 cross-track VIS/NIR pixels accumulated while the mirror sweeps through one AIRS instantaneous FOV.

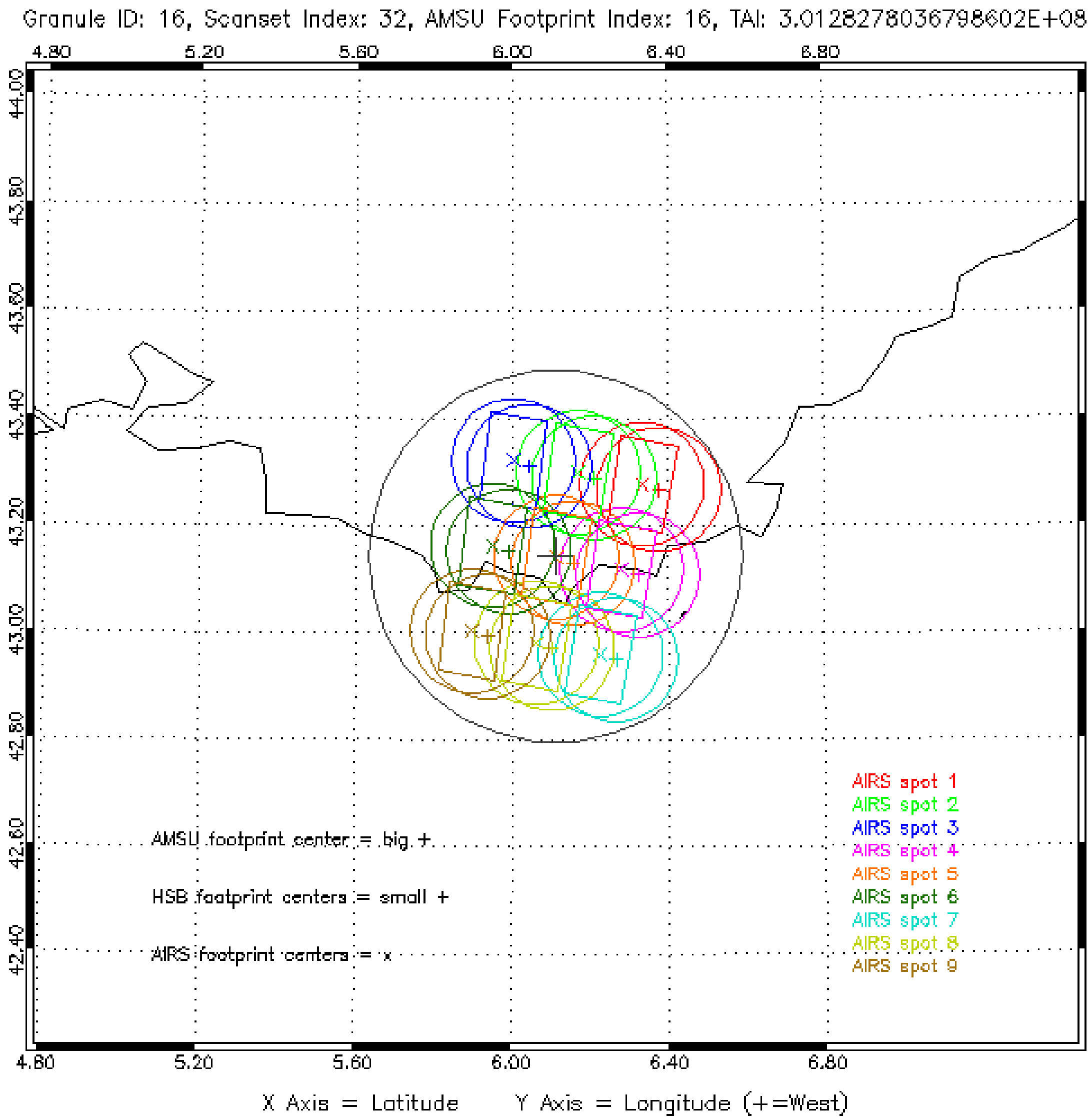


Figure 1: AIRS/AMSU/HSB Footprint Pattern

AIRS Science Processing System

System Overview

The AIRS Science Processing System (SPS) is a collection of programs, or Product Generation Executives (PGEs), used to process AIRS Science Data. These PGEs process raw, low level AIRS Infrared (AIRS), AIRS Visible (VIS), AMSU, and HSB instrument data to obtain temperature and humidity profiles.

AIRS PGEs can be grouped into three distinct processing phases for processing: Level 1A, Level 1B and Level 2. Each consecutive processing phase yields a higher-level data product. Levels 1A and 1B result in calibrated, geolocated radiance products. Level 2 processing derives temperature and humidity profiles. In addition to the standard processing PGEs, there are additional Browse PGEs that are run to produce aggregate qualitative summary for each standard product. Figure 2 is a diagram illustrating the processing flow of the AIRS Science Processing System.

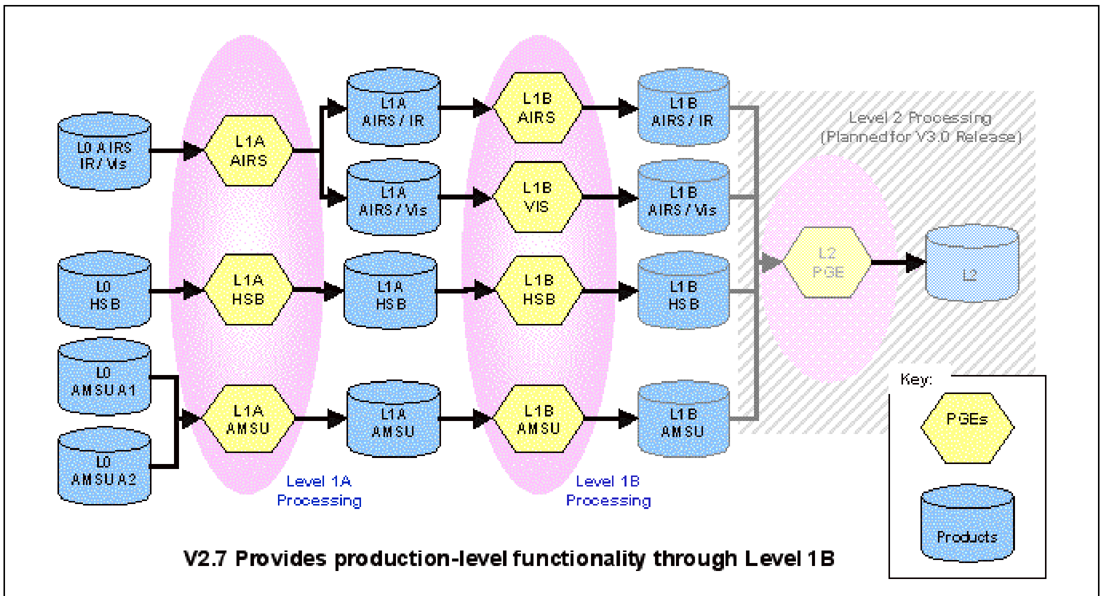


Figure 2: AIRS Science Processing System Processing Flow

Note, Level 2 products are not yet available. The Level 2 PGE will be included in a future release.

Data Processing –Version 2.7

The V2.7 Release Science Processing Software (SPS) provided to the GSFC DAAC for L1B Product Generation is version 2.7.12.0 and represents the best refinement of all Level 1A and Level 1B PGEs as of January 21, 2003. It contains working versions of all Level 1A and Level 1B software modules. Specific features and characteristics of version 2.7.12.0 are described in other sections of this documentation.

The enhancements to Level 1A and Level 1B reflect lessons learned from analysis of post-launch data. The software is still under development, and JPL plans to continue to upgrade PGEs and will deliver updated code modules to the GSFC DAAC to support public release of Level 2 products during the middle of 2003 at approximately Launch + 13 months.

Level-1A Processing

AIRS data processing begins with receipt of Level 0 data from EDOS. When Level 0 data are received, Level 1A PGEs are scheduled. The Level 1A PGEs perform basic house keeping tasks such as ensuring that all the Level 0 data are present and ordering the data into time of observation synchronization. Once the Level 0 data are organized, algorithms that perform geolocation refinement and conversion of raw Data Numbers to Engineering Units (DN to EU). Finally, the level 1A data are collected into granules of data (six minutes of instrument data) and are forwarded to Level 1B PGEs for further processing.

Level-1B Processing

Level 1B PGEs receive 240 granules of AIRS (AIRS IR, AIRS VIS, AMSU and HSB) Level 1A EU data and produce calibrated, geolocated radiance products. Calibration data and calibration control parameters are analyzed to develop processing specifications for Level 1B processing. Then, the Level 1A data are processed, yielding our Level 1B standard products. Each type of AIRS Level 1A data is processed by a specialized Level 1B PGE. Each Level 1B PGE generates 240 granules of Level 1B standard products.

Level 1B PGEs produce 240 granules of 4 Level 1B standard products and 2 quality assessment (QA) subset products. Each granule is composed of 45 scansets. The Earth Science Data Type (ESDT) short names and normal granule sizes are:

Data Set	Short Name	Granule Size
L1B AMSU-A brightness temperatures	AIRABRAD	0.4 MB
L1B HSB brightness temperatures	AIRHBRAD	1.6 MB
L1B AIRS radiances	AIRIBRAD	122.1 MB
L1B VIS radiances	AIRVBRAD	21.0 MB
L1B AIRS QA	AIRIBQAP	6.5 MB
L1B VIS QA	AIRVBQAP	0.9 MB

The AIRS Calibration Team documents the required inputs and outputs of the AIRS IR and VIS/NIR Level 1B processing software, algorithms for converting AIRS IR digital numbers to calibrated radiances, and QA algorithms and indicators in "**Atmospheric Infrared Sounder (AIRS) Level 1B Visible, Infrared and Telemetry Algorithms and Quality Assessment (QA) Processing Requirements**." Version 2.2 of this document, dated 2/14/03, is available at the link:

L1B_req_v2.2.pdf

The interested user will find additional information on QA indicators for AIRS IR and VIS/NIR L1B products in this document.

Experience with on-orbit AIRS data prompted the AIRS Calibration Team to alter some AIRS L1B algorithms (e.g. **AutomaticQAFlag**, DC Restore, pop detection, Moon-in-view, offset, noise estimation and gain). A brief AIRS Design File Memo describing these changes, dated 2/4/03, is available at the link:

l1bqa_changes.pdf

An AIRS Design File Memo (ADF-579) provides the initial assessment of the on-orbit performance of the VIS/NIR system, dated 6/12/02. It is available at the link:

VisInitialCheckout_.pdf

Another AIRS Design File Memo (ADF-590-REVISED) dated 9/27/02 provides the results of the first accurate determination of instrument gains of the VIS/NIR detectors on-orbit via vicarious calibration in conjunction with the MISR-Terra Calibration Team operations at Railroad Valley Playa, Nevada. It is available at the link:

VisGainCalibration.pdf

V2.7 Release of L1B Data Information

Data Disclaimer and Quick Start Quality Assurance

Data Disclaimer

The accompanying file:

Data_Disclaimer.pdf

provides information which affects the availability of data for ordering (i.e., may be unavailable due to instrument outage or spacecraft maneuvering). It also lists the known liens against each instrument.

Quick Start Quality Assurance

The accompanying file:

QA_Quick_Start.pdf

Is a guide to the most basic quality assurance (QA) parameters that a novice user of AIRS/AMSU/HSB data should access to judge its quality.

AIRS

AIRS IR channel characteristics

The properties of the 2378 AIRS instrument detectors are individually listed in self-documenting text files. Some properties of the channels change slowly with time or discontinuously whenever the instrument is warmed by a spacecraft safety shutdown or in a defrost cycle. Whenever this occurs, a recalibration exercise is performed and a new channel properties file created. Thus a series of these files will result. The L1B PGE must use the proper one for initial processing and later on if the data must be reprocessed.

The file names contain a date, identifying the first date for which they are valid (and supersede a channel properties file containing an earlier date). As of this release, there are four such files covering the time period from 8/30/02 to the present. Text versions may be accessed through the following links:

Channel Properties Files
L2.chan_prop.2002.08.30.v6.6.2.pdf
L2.chan_prop.2002.09.17.v6.6.3.pdf
L2.chan_prop.2002.10.22.v6.6.4.pdf
L2.chan_prop.2003.01.10.v6.6.7.pdf

Instrument state

- Instrument is in nominal science mode (instrument flag **OpMode** = ‘Operate’)
- The quality of the calibration is judged to be good

Radiometric calibration

- Link to paper, “**First Radiometric Validation of AIRS on the EO using the 20 July 2002 Focus Day Data**” by Aumann and Strow, which uses analysis of (observed – calculated) for data from a single, relatively cloud free granule in the subtropical Atlantic ocean to confirm absolute radiometric accuracy of better than 0.5 K. A representative portion of the bias spectrum from the paper is shown in Figure 3.

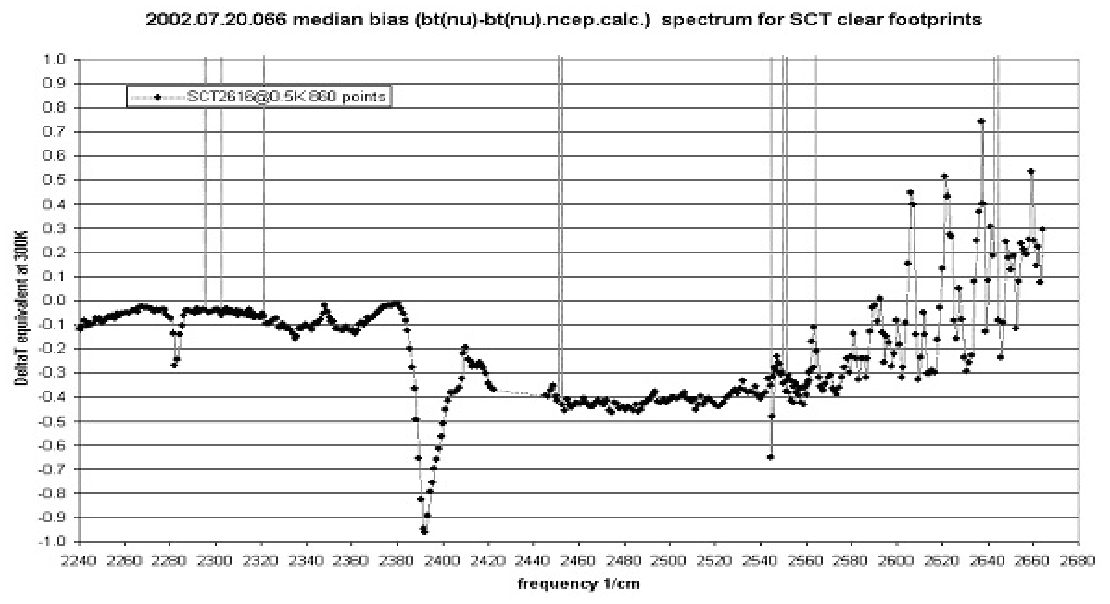


Figure 3: Plot of calculated radiometric residuals for clear-view ocean footprints. Units are Kelvins. The plot is versus frequency in wavenumbers.

- Link to paper, “**An Evaluation of the Accuracy of AIRS Radiances from Sea Surface Temerature Measurements**” by Hagan presents an analysis of (buoy_obs_SST – AIRS_TOA) for data from two months of nighttime AIRS observations compared to buoy measurements co-located in space and time to within ±50km and 2 hours respectively. The global bias and standard deviation are –0.1 ± 1.1 K at 938 cm^{-1} and –0.3 ± 1.1` K at 2616 cm^{-1}.

- Radiometric sensitivity is excellent. Figure 4 is a display of the noise equivalent temperatures as a function of wavelength.

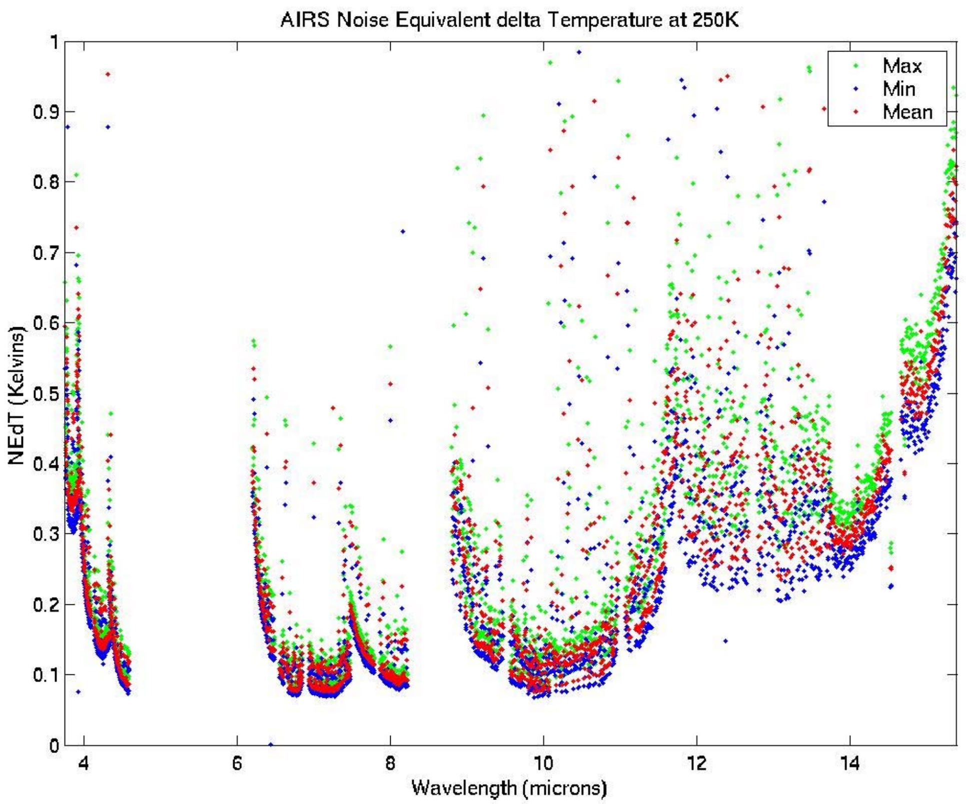


Figure 4: Plot of channel Noise Equivalent Temperatures. Units are Kelvins. The plot is versus wavelength in microns.

Spectral Calibration

- Preliminary validation indicates that the absolute spectral accuracy is equivalent to less than 0.5% of the detector spectral response function (SRF) full width at half maximum (FWHM). Spectral stability and sensitivity are 0.02% FWHM level. See Figure 5.
- The SRF centroids are provided in the accompanying channel properties file.

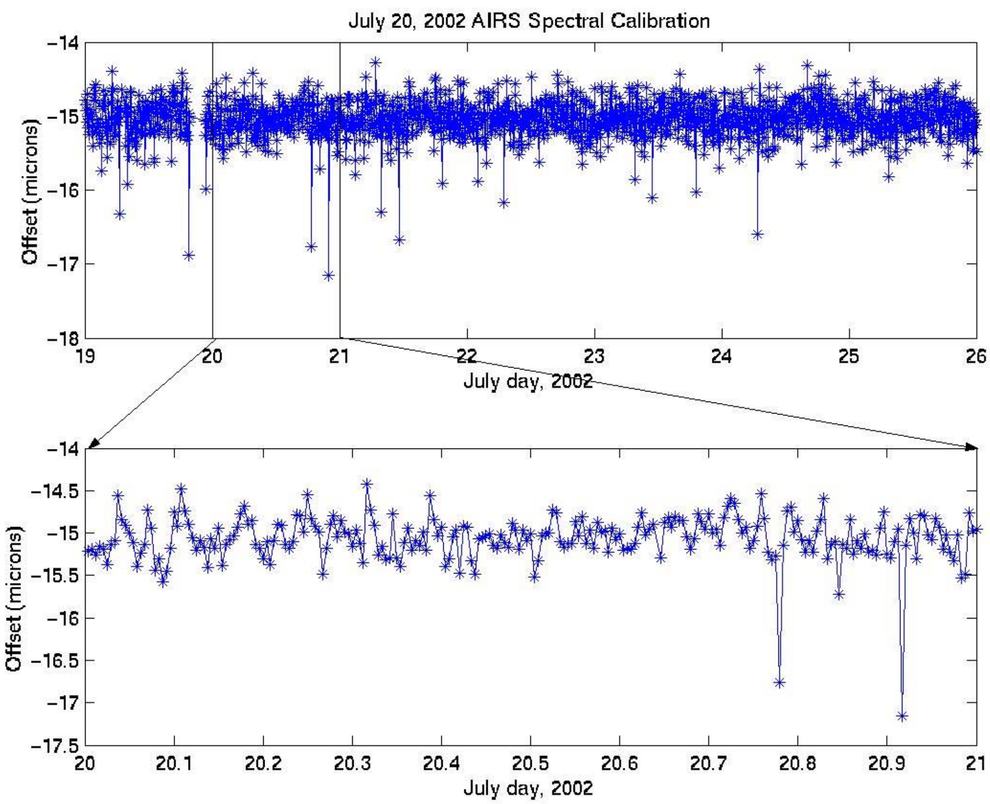
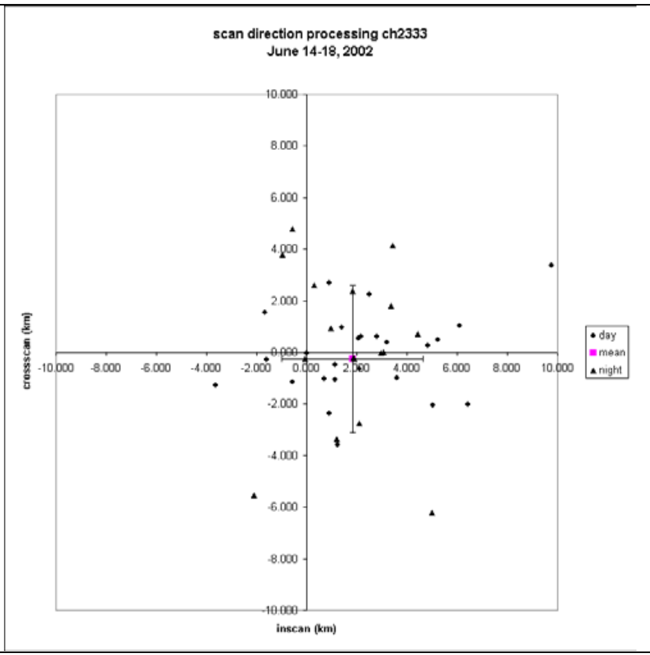


Figure 5: Plot of calculated spectral offsets. Units of focal plane displacement are microns.

Spatial Calibration

AIRS data for June 14-18, 2002 have been processed using a coastline detection to provide preliminary information on the AIRS boresight. Please see the accompanying document, **AIRS_Boresight_Method.pdf** for details.

Figures 6a and 6b show the results of this analysis for two processing modes, scan and track direction processing. The two modes are consistent with each other and consistent with a two kilometer offset in the beam position. The satellite track direction is up and the mirror scan direction is left to right in both figures. The figure axes are referenced to the WVS coastline map.



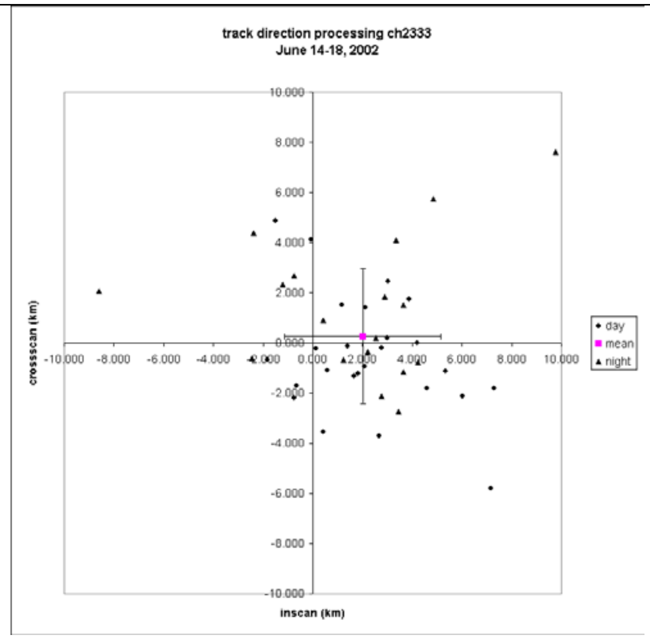


Figure 6: Plot of calculated spatial residuals. Individual residuals are plotted in kilometers

(a): along-scan (i.e., cross-track) | (b): along-track

The data come from a worldwide distribution of 43 granules that correspond to clear areas of quality A through C as discussed in the above reference. We carefully selected areas that had both large and small (but potentially useful) regions of clear coastline in order to maximize the amount of data over the short time period used in June. The data consist of 25 day and 18 night scenes. The error bars on the graph denote the standard deviation of the population. The standard deviation of the mean for these data would be about 6.6 times smaller (about 0.4 km) than the population standard deviation (about 2.8 km) if the distribution were gaussian, however, there are systematic errors in the data, possibly from cloud contamination.

Optimal use of the AIRS data with AMSU and HSB data requires knowledge of the AIRS boresight to about 2 km. Planned use of the AIRS visible for cloud flagging requires that the boresight position be known to 1.3 km. These requirements are both met with a standard deviation of the mean of about 2.2, which is not unreasonable for these data. Users should be aware that there appears to be a 2 km shift in the geolocation data in the +direction of the mirror scan.

VIS/NIR

Instrument state

- Nominal science mode

Radiometric calibration

- Within each channel, detector-to-detector relative errors are believed to be ~1%. Absolute system calibration is good to ~10% in each channel.

Pointing

- Geolocation has been validated to 0.16 degrees (corresponding to 2 km at nadir)

  (Note: To reduce the data volume, not every VIS/NIR pixel is geolocated. Instead, only the four “corner pixels” of the 9x8 grouping associated with each IR footprint are geolocated. (A bi-linear interpolation can be used to locate the remaining pixels.) In the data files, four-element arrays called “cornerlats” and “cornerlons” carry this information. The first array element is the upper-left pixel when viewing an image aligned with “up” being North. The second element is the upper-right pixel. The third and fourth elements refer to the lower-left and lower-right pixels, respectively.

Enhanced L1B Product Since Sample Data Release

- Release V2.7 of L1B data contains seven new Vis/NIR products over that which were available in the July 20, 2002 Sample Data Release. These are preliminary estimates of cloud and surface properties, and the Level 2 Support files will contain more accurate values. The products are as follows (see the accompanying interface specifications document for additional details):
    - PrelimCldMapVis: At Vis/NIR resolution, a true/false flag for whether or not clouds are present in the pixel (1=cloudy, 0=clear, -1=unknown).
    - PrelimClrPrcVis: At IR resolution, the percentage of the footprint believed to be clear.
    - PrelimClrPrcVisErr: At IR resolution, an error estimate on the above quantity.
    - PrelimCldPrcVis: At IR resolution, the percentage of the footprint believed to be cloudy.
    - PrelimCldPrcVisErr: At IR resolution, an error estimate on the above quantity.
    - PrelimNDVI: At Vis/NIR resolution, an estimate of the surface normalized differential vegetation index (NDVI). This NDVI value is taken from a global surface map made using AVHRR data from the early 1990's prepared by the Global Land 1-km AVHRR Project see the website <**http://edcdaac.usgs.gov/1KM/1kmhomepage.html**>.
    - PrelimCldQA: A true/false flag for whether or not problems were encountered during cloud detection. A value of zero implies no problems detected, cloud and surface information believed to be reliable. A value of one implies results are suspect.

VIS/NIR channel characteristics

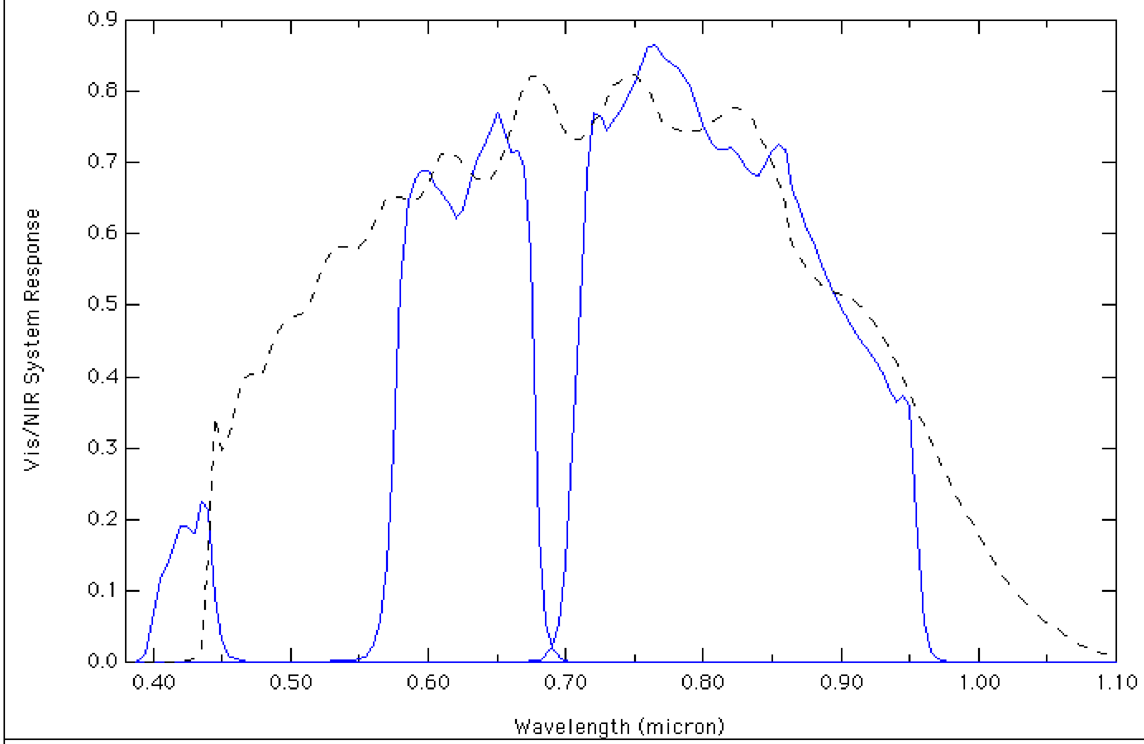


Figure 7: The approximate spectral response of the four VIS/NIR channels. The three solid curves are, from left to right, Channels 1, 2, and 3. The dashed curve is the response of Channel 4.

Channel 1 (0.40 to 0.44 µm) is designed to be most sensitive to aerosols. Channels 2 (0.58 to 0.68 µm) and 3 (0.71 to 0.92 µm) approximate the response of AVHRR channels 1 and 2, respectively, and are particularly useful for surface studies. (AVHRR is an imaging instrument currently carried by NOAA polar orbiting satellites.) Channel 4 has a broadband response (0.49 to 0.94 µm) for energy balance studies.

AMSU-A

Instrument state

- Instrument is in nominal science mode
- Both AMSU modules are in the optimal space view position

Radiometric calibration

- The data have been reprocessed with the current best calibration algorithm and calibration parameters.
- Calibration accuracy is estimated to be on the order of 1 K
- Radiometric sensitivity is better than requirements – see AMSU-A channel characteristics table, below.
- The quality of the calibration is judged to be good, but at present there are substantial scan biases. Modeling of the sidelobe pickup is under way to correct these scan biases.
- Channel 7 has additional correlated noise, and should be avoided in applications that use single measurements, such as comparisons with collocated soundings. It may be used in applications in which some averaging is done (i.e. gridding/binning or regional averages)
- Channel 6 exhibits additional correlated noise; similar to channel 7 but much smaller
- Channel 9 exhibits occasional popping, i.e. the calibration counts suddenly drop and then quickly recover. This typically occurs no more than once per orbit.
- Channel 14 may have correlated noise, but it is minor

Preliminary Pointing Analysis using Coastlines

- Valid for channels 1, 2, 3, 15 (window channels)
- Pitch error < 10% of FOV (< 4 km at nadir)
- Roll Error estimated to be less than 20% of FOV
- Yaw error estimated to be less than 30% of FOV at swath edge

Relevant analysis

- See Accompanying Document: **MW_L1B_Assessment.pdf** which is based upon a status report given to the AIRS Science Team in September 2002 and has been updated as of March 10, 2003.

AMSU-A channel characteristics

Ch #	Module	Center freq [MHz]	Stability [MHz]	Bandwidth [MHz]	On-Orbit NEdT[K]	T/V NEdT[K]	Pol
1	A2	23800	±10	1x270	0.17	0.17	V
2	A2	31400	±10	1x180	0.19	0.25	V
3	A1	50300	±10	1x160	0.21	0.25	V
4	A1	52800	±5	1x380	0.12	0.14	V
5	A1	53596±115	±5	2x170	0.16	0.19	H
6	A1	54400	±5	1x380	0.21	0.17	H
7	A1	54940	±5	1x380	0.21	0.14	V
8	A1	55500	±10	1x310	0.14	0.16	H
9	A1	[f_0]=57290.344	±0.5	1x310	0.14	0.16	H
10	A1	f_0±217	±0.5	2x77	0.19	0.22	H
11	A1	f_0±322.4±48	±1.2	4x35	0.22	0.24	H
12	A1	f_0±322.4±22	±1.2	4x16	0.31	0.36	H
13	A1	f_0±322.4±10	±0.5	4x8	0.43	0.50	H
14	A1	f_0±322.4±4.5	±0.5	4x3	0.71	0.81	H
15	A1	89000	±130	1x2000	0.10	0.12	V

HSB

Instrument state

- Instrument was placed in survival mode Feb 5, 2003, and remains as of this writing (March 10, 2003). The expectation is that the instrument will be started up and returned to nominal science mode after the investigation ends.
- HSB is in its optimal space view position.

Radiometric calibration

- The data have been reprocessed with the current best calibration algorithm and calibration parameters.
- Calibration accuracy is estimated to be on the order of 1 K
- Radiometric sensitivity is better than requirements – see HSB channel characteristics table, below.
- The quality of the calibration is judged to be good, but at present there are substantial scan biases. Modeling of the sidelobe pickup is under way to correct these scan biases.

Preliminary Pointing Analysis using Coastlines

- Valid for channel 2 (window channel)
- Pitch error < 10% of FOV (< 1.5 km at nadir)
- Roll Error estimated to be less than 20% of FOV
- Yaw error estimated to be less than 30% of FOV at swath edge

Relevant analysis

- See Accompanying Document: **MW_L1B_Assessment.pdf** which is based upon a status report given to the AIRS Science Team in September 2002 and has been updated as of March 10, 2003.

HSB channel characteristics

Ch #	Center freq [MHz]	Stability [MHz]	Bandwidth [MHz]	On-Orbit NEdT[K]	T/V NEdT[K]	Pol
1	AMSU-B channel 1 was not implemented for HSB					
2	150000	±100	2x1000	0.58	0.68	V
3	183310±1000	±50	2x500	0.55	0.57	V
4	183310±3000	±70	2x1000	0.35	0.39	V
5	183310±7000	±70	2x2000	0.28	0.30	V

Sample Data Readers

The AIRS Project releases to the broad scientific community sample data readers under IDL to facilitate user community use of on-orbit Level-1B AIRS/AMSU/HSB radiances.

The user community must realize that the AIRS Project does not have the resources to support consultation on these readers. They are being provided as an aid to give the user community a leg up in using the data. There is no commitment to provide assistance to the broad user community beyond the release of these readers.

IDL Readers

read_swath_l1_airs.pro.pdf

minimal call sequence:

read_swath_l1_airs, pattern, numfp, numline, tai, lat, lon, rad, solzen

input:

pattern	path/filename of AIRS L1B product to be read

output:

numfp	number of AIRS footprints in swath scanline (usually = **GeoXTrack** = 90)
numline	number of AIRS scanlines in swath (usually = **GeoTrack** = 135)
tai	array of AIRS footprint tai (tai[numfp,numline]), sec
lat	array of AIRS footprint latitudes (lat[numfp, numline]), deg
lon	array of AIRS footprint longitudes (lon[numfp, numline]), deg
rad	array of AIRS radiances (rad[Channel, numfp, numline]), milliWatts/m**2/cm**-1/sterad where **Channel** = 2378
solzen	array of AIRS footprint solar zenith angles (solzen[numfp,numline]), deg

expanded call sequence:

read_swath_l1_airs, pattern, numfp, numline, tai, lat, lon, rad, solzen
full_swath_data_field_name_1=variable_1_to_hold_it
full_swath_data_field_name_n=variable_n_to_hold_it

where the code supplied already supports these optional full swath data field names: scangang, sun_glint_distance, CalFlag, freq, topog, state

The user can add more optional data fields by using the code as an example.

read_swath_l1_vis.pro.pdf

minimal call sequence:

read_swath_l1_vis, pattern, cornerlats, cornerlons, rad

input:

pattern	path/filename of VIS L1B product to be read

output:

cornerlats	array of VIS geodetic latitudes at the centers of the pixels at the corners of the IR footprint by channel in degrees north (lat[GeoTrack, GeoXTrack, GeoLocationsPerSpot, Channel]), deg
cornerlons	array of VIS geodetic longitudes at the centers of the pixels at the corners of the IR footprint by channel in degrees East (range from –180 to +180) (lon[GeoTrack, GeoXTrack, GeoLocationsPerSpot, Channel]), deg
rad	array of VIS radiances (rad[GeoTrack, GeoXTrack, Channel, SubTrack, SubXTrack]), in Watts/m**2/micron/steradian where **Channel** = 4, **SubTrack** = 9, **SubXTrack** = 8, **GeoTrack** = 135, **GeoXTrack** = 90 and **GeoLocationsPerSpot** = 4. The storage order of the **GeoLocationsPerSpot** (corners) is: AlongTrack Foreward Edge, CrossTrack ScanStart Edge AlongTrack Foreward Edge, CrossTrack ScanEnd Edge AlongTrack Trailing Edge, CrossTrack ScanStart Edge AlongTrack Trailing Edge, CrossTrack ScanEnd Edge where foreward edge is the edge of the swath data field closest to the direction the satellite is traveling and scanend edge is the edge of the swath data field closest to the end of a crosstrack scan. The example reader fills this array with the swath data field named **radiances**

The user can add more optional data fields by using the code as an example.

read_swath_l1_amsu.pro.pdf

minimal call sequence:

read_swath_l1_amsu, pattern, numfp, numline, tai, lat, lon, rad, solzen

input:

pattern	path/filename of AMSU L1B product to be read

output:

numfp	number of AMSU footprints in swath scanline (usually = **GeoXTrack** = 30)
numline	number of AMSU scanlines in swath (usually = **GeoTrack** = 45)
tai	array of AMSU footprint tai (tai[numfp,numline]), sec
lat	array of AMSU footprint latitudes (lat[numfp, numline]), deg
lon	array of AMSU footprint longitudes (lon[numfp, numline]), deg
rad	array of AMSU radiances (rad[Channel, numfp, numline]), K where **Channel** = 15. The example reader fills this array with the swath data field named **brightness_temp**
solzen	array of AMSU footprint solar zenith angles (solzen[numfp,numline]), deg

expanded call sequence:

```
read_swath_l1_amsu, pattern, numfp, numline, tai, lat, lon, rad, solzen
        full_swath_data_field_name_1=variable_1_to_hold_it
        full_swath_data_field_name_n=variable_n_to_hold_it
```

where the code supplied already supports these optional full swath data field names: scangang, sun_glint_distance, CalFlag, freq, topog, state

The user can add more optional data fields by using the code as an example.

read_swath_l1_hsb.pro.pdf

minimal call sequence:

read_swath_l1_hsb, pattern, numfp, numline, tai, lat, lon, rad, solzen

input:

pattern	path/filename of AMSU L1B product to be read

output:

numfp	number of HSB footprints in swath scanline (usually = **GeoXTrack** = 90)
numline	number of HSB scanlines in swath (usually = **GeoTrack** = 135)
tai	array of HSB footprint tai (tai[numfp,numline]), sec
lat	array of HSB footprint latitudes (lat[numfp, numline]), deg
lon	array of HSB footprint longitudes (lon[numfp, numline]), deg
rad	array of HSB radiances (rad[Channel, numfp, numline]), K where **Channel** = 5. The example reader fills this array with the swath data field named **brightness_temp**
solzen	array of HSB footprint solar zenith angles (solzen[numfp,numline]), deg

expanded call sequence:

read_swath_l1_hsb, pattern, numfp, numline, tai, lat, lon, rad, solzen
full_swath_data_field_name_1=variable_1_to_hold_it
full_swath_data_field_name_n=variable_n_to_hold_it

where the code supplied already supports these optional full swath data field names: scangang, sun_glint_distance, satheight

The user can add more optional data fields by using the code as an example.